Chemical dips and treatments to enhance shelf-life and retard browning of litchi (*litchi chinensis* sonn.)

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Received: September 23, 2018 Accepted: November 02, 2018

ABSTRACT: *Litchi (litchi chinensis sonn.) is the most important fascinating sub-tropical fruit which deteriorates rapidly within 24 hours after harvest if stored at ambient temperature. Rose scented variety of litchi was taken as a sample for sensory evaluation. The litchi fruit was treated with different chemicals and temperatures. Studies were carried out to observe the effect of chemical dipping treatments consisted of HCl, Ca $(NO_3)_2$, oxalic acid, phosphoric acid, nitric acid solutions. Freshly harvested and precooled litchi fruits during storage at the ambient conditions (26^0C-39^0C). Precooled litchi dipped in hot water (55^0C for 12 min), HNO_3 (1.5% for 10 min) and $CaCl_2$ solution (2% for 15 min). Data recorded on the sensory characters of fruits was done using five point scale during storage were also analyzed statistically. Result indicated that dipping of freshly harvested and precooled litchi in hot water (55^0C for 12 min), HNO_3 (1.5% for 10 min) and then in $CaCl_2$ solution (2% for 15 min) may successfully be employed as an alternative treatment to sulphitation as the treated fruit by this method were found acceptable the longest 4 days at ambient condition and also increase shelf life 18 days acceptable thereafter declined, organoleptic data recorded 27 days after packaging in paper boxes (4% ventilation) and 4% perforated polyethylene bags (165 gauze) were kept at cold conditions (4-5^0C, 85-90% RH) for the storage studies as compared with the treated sample only packed in 2% perforated polythene sachet (165 gauge) were stored at ambient conditions for four days.*

Key Words: *Litchi Fruit, Chemical dip, Browning, Cold storage, and shelf life, post-harvest, Sensory evaluation*

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Introduction

Litchi (*Litchi chinensis* Sonn.) is a tropical to subtropical crop that originated in South-East Asia **(Jiang, 2006*)***. It belongs to the family *Sapindaceae* that covers around 2000 genus and 150 genera **(Pandey and Sharma, 1989)**. India is the second largest producer of litchi next to China, with an annual production of 418.4 thousand metric tones from an area of 69.2 thousand hectares **(NHB, 2008)**. Litchi is a non-climacteric fruit **(Holocroft and Mitcham, 1996)**. It is a drupe or stone fruit and at maturity it is conical, heart shaped or spherical with a thick leathery, indehiscent pericarp **(Revethy and Narasimhan, 1997)**. Litchi fruit has good export demand and vast export potential, yet it is not a major commercial crop, mainly because of its seasonal availability and short shelf-life. It is a very delicate fruit and highly perishable in nature, with an average moisture content of 84.3% **(Singh et al., 1963)**. The shelf-life of litchi is never more than 24-72 h at ambient conditions **(Kumar, 2000)**. Litchi fruits usually come in the market right from the month of May till early part of July, when very few other kinds of fresh fruits are available. Litchi is known for its pleasant flavour, juicy pulp (aril) with attractive red colour pericarp. It is also an excellent source of vitamins and minerals **(Chadha, 2001)**. The daily vitamin C requirement of an average adult can be met by consuming 14-17 litchis **(Wall, 2006)**. Under ambient conditions, it loose upto 7-11% weight within one day after harvest **(Wu et al., 1997)**. The attractive bright red colour may be lost within 48 h. Desiccation during post harvest handling accompanied by loss of red colour and pericarp browning has posed a major problem in its storage, transport and marketing **(Underhill and Critchley, 1993)**. Dessication also accelerates enzymatic action which initiates the browning process. Desiccation browning is the most noticeable symptom of moisture loss **(Shi *et al.,* 2001)**. Litchi shipped to long distance markets is normally treated with sulfur to prevent browning. This treatment has been shown to extend storage life, inhibit browning and limit the need for specialized packaging and handling **(Kadam and Salunkhe, 2005)**.

However, the use of sulphites has some disadvantages in particular dangerous side effects for asthmatics. For this reason, the Food and Drug Administration in the USA has partly restricted the use of sulphites **(Anonmyous, 1991)**. The main objective of present investigation to extend the shelf-life and retard browning of litchi fruits by employed different post-harvest treatments.

Material and Methods

Source of material

The ripe fruits (TSS 17-19%) of litchi (*Litchi chinensis* Sonn.) of cultivar Rose Scented used for this investigation were procured from the Horticulture Research Center, Pattarchatta, G.B. Pant University of Agriculture and Technology Pantnagar, U.S. Nagar (Uttarakhand) during the peak season (June). The chemicals and the reagents employed in the present study were of AR grade. **Preparation of litchi for post harvest treatments**

The litchi fruit bunches after harvesting were collected immediately in cloth bags, covered with thick layer of green litchi leaves and taken to the laboratory within an hour by avoiding jerks during the transit. Fruits were destalked retaining about 2 mm long pedicel with each fruit using a stainless steel scissors. Ripe, healthy and uniform sized litchi fruits free from blemishes, any visible sign of disease, infestation and physical injury were selected.

Methodology of post-harvest treatments of litchi

Sulphitation

It was carried out by fumigation of sulfur dioxide gas in a closed chamber (14×14×14 cm) for 45 min. Litchi fruits were kept in perforated aluminium trays placed in this chamber. Sulfur dioxide gas was produced by igniting pure sulfur powder at the rate of 300 mg sulfur per kilogram fruits.

Hot water treatment (HWT)

For this treatment fruits were steeped in a thermostatically maintained water bath (UNILAB) at 55±1 ^{0}C for 12 min and following this fruits were cooled by dipping in cold water bath (15±1 ^{0}C) for 10 min and thereafter were subjected to chemical treatments.

Boiling water treatment (BWT)

This treatment was given by steeping the litchi fruits in boiling water (98±2 ^{0}C) in a thermostatically maintained water bath (UNILAB) for 30 sec. After this treatment fruits were immediately cooled in a cold water bath (15±1^{0}C) for 10 min. Thereafter, these fruits were subjected to chemical treatments.

HCl Vapour treatment

Litchi fruits were kept on the perforated trays kept in a closed cabinet (14×14×14 cm) for HCl vapour treatment. HCl vapours were produced by heating (40±2^{0}C) 50 ml of concentrated acid in this chamber by a mantle heater. Vapour treatments were carried out for 5 and 8 min.

Dipping in acid solution and salt solution

Acid solutions i.e. Oxalic acid (0.25%,1%,5%,10%), Nitric acid (0.5%,1.5%), Phosphoric acid (4%,6%,8%) and salt solution i.e. Calcium Nitrate (2%,3%) were prepared in distilled water. Litchi fruits were steeped in these solutions as per the treatment and fruit to solution ratio was 1:3.

Table 1 Details of post-harvest treatments of litchi fruits

S.NO.	Treatments
T_1	No treatment (control)
T_2	Precooling
T_3	*HWT
T_4	HWT Followed by dipping in 1.5% HNO_3 for 10 min
T_5	HWT Followed by dipping in 1.5% HNO_3 for 10 min and then in 2% $CaCl_2$ for 15 min
T_6	HWT Followed by dipping in 1.5% HNO_3 for 10 min and then in 2% $CaCl_2$ for 30 min

*HWT stands for hot water treatment (55±1^0 for 12 min), respectively.

Organoleptic quality

The litchi fruit samples were evaluated for their organoleptic attributes namely appearance/colour, odour, taste, texture and overall acceptability by a semi-trained panel comprising of ten panelists. **(Larmond, 1977)**

Statistical analysis:

Statistical analysis of the data obtained in the present investigation was carried out using Analysis of Variance (ANOVA) as described by **Snedecor and Cochran (1968)** on a completely randomized design.

Results

The treated sample packed in 2% perforated polythene sachet (165 gauge) were stored at ambient conditions for four days. Litchi fruits were also subjected to organoleptic evaluation after an interval of 24 hours according to five point hedonic scale. The organoleptic profile of litchi fruit showed that T_5 treatment obtained maximum scores for all sensory parameters. Among these six, T_5 treatment i.e. HWT+1.5% HNO_3 for 10 min+2% $CaCl_2$ for 15 min was consider to be an ideal pretreatment to extent the shelf life of litchi fruit. It seems that precooling, hot water and hot water-acid dip treatment reducing surface microflora and disinfestations and for lowering the pH to retard browning is unable to minimize the changes in the sensory attributes of litchi during the ambient storage. Hence, $Ca(NO_3)_2$ that might be assumed to be produced due to the presence of HNO_3 and $CaCl_2$ was possibly responsible for retaining the most of the sensory properties. It might be due to decrease in the respiration rates and moisture losses from the fruits because of $Ca(NO_3)_2$ **(Patra and Sadhu, 1992; Duvehage *et al.,* 1995; Ghosh *et al.,* 2003; Singh *et al.,* 2004).**

Changes in sensory characters of litchi during ambient storage

Changes in sensory attributes namely appearance/ colour taste, aroma, texture and overall acceptability of litchi due to pretreatments and ambient storage are presented in Table 2. It can be seen that organoleptic ratings for all the attributes decreased with the progress of storage period in all the cases. Results showed that sensory profile of most of sample remained unaltered (organoleptic score 5) just following the pretreatments, however, ratings for appearance/colour, taste, and overall acceptability decreased slightly ranging from 4.25-4.75 just after the hot water treatment (T_3) alone.

The treatment T_5 was found to exhibit maximum organoleptic score following four days of storage which was 4.25, 4.35, 3.55, 4.20 and 4.20 for appearance/colour, taste, odour, texture and overall acceptability, respectively. The shelf-life of litchi on the basis of overall acceptability score (≥3.00) was 1, 2,3, 4 days due to control, and pretreatments T_4, T_5 and T_6, respectively. The effects of pretreatments, storage period and their interactions on the organoleptic ratings for all the parameters were found to be statistically significant.

Table 2 showed that the organoleptic scores for all the sensory attributes namely appearance/colour, odour, taste, texture and overall acceptability exhibited declining trends with the progress of storage period due to all the treatments of corresponding maximum scores following four days of ambient storage were 4.25, 4.35, 3.55, 4.20 and 4.20 with the treatment T_5 (hot water dip at 55^0C for 12 min + 1.5%HNO_3 dip for 10 min +2%$CaCl_2$ for 15 min) and the treated sample packed in 2% perforated polythene sachet (165 gauge) were stored at ambient conditions for four days Statistical analysis of the data revealed that the effects of pretreatments, storage period and their interactions on the sensory scores for all the parameters were found significant.

Table:-2. Influence of pretreatments on organoleptic characteristics of litchi during ambient storage

Treatments		Appearance		Taste		Odor		Texture		Overall acceptability	
		Day 4	mean	Day 4	mean	Day 4	mean	Day 4	mean	Day 4	mean
T1	No treatment	1.25	2.76	1.05	2.45	1.30	2.60	1.40	2.72	1.40	2.83
T2	Precooling	1.55	2.66	1.10	2.66	1.60	2.87	1.85	3.12	1.85	2.91
T3	HWT	1.00	2.45	1.05	2.29	1.05	2.41	1.50	2.90	1.50	2.54
T4	HWT+1.5% HNO3 for 10 min	2.20	3.32	2.40	3.47	2.40	3.16	2.30	3.50	2.30	3.37
T5	HWT+1.5% HNO3 for 10 min+2% CaCl2 for 15 min	4.25	4.67	4.35	4.79	3.55	4.34	4.20	4.64	4.20	4.64
T6	HWT+1.5% HNO3 for 10 min+2% CaCl2 for 15 min	3.90	4.50	4.10	4.50	3.40	4.03	4.20	4.51	3.75	4.37
	Means	2.36	3.39	2.34	3.33	2.22	3.24	2.58	3.57	2.50	3.44

*mean scores was calculated 0, 1,2,3,4 days of T_1, T_2, T_3, T_4, T_5 and T_6, respectively.

Changes in sensory characters of litchi during cold storage

Results on changes in sensory characters namely appearance/ colour, taste, odour, texture and overall acceptability of fruits due to pretreatments, storage period and types of packaging are presented in Table 2. All the organoleptic parameters were influenced significantly due to pretreatments, storage period, types of packaging and interactions thereof. Ratings for all the sensory attributes were more than 3 due to T_3

treatment irrespective of types of packaging and even after end of 27 days of storage period. The appearance/colour, taste, odour and overall acceptability scores of litchi were however less than 3 with the sulphited samples during the entire storage period of 9 days.

The ratings for all the sensory characters exhibited decreasing trends with the progress of storage period due to control and T_3 treatment but the colour/appearance, taste, odour and overall acceptability scores of sulfited litchi samples were found to improve with the advancement of storage period.

Litchi fruits treated with T_3 (hot water dip at 55^0C for 12 min + 1.5%HNO_3 dip for 10 min + 2%$CaCl_2$ for 15 min) treatment were acceptable (organoleptic score≥3) even after the end of 27 days of cold storage however the organoleptic score of sulphited fruit samples was ≤3 during the entire storage period of nine days. The findings also revealed that the shelf-life of T_3 treated litchi fruits was not less than 27 days when stored under the cold conditions (4-5^0C and 85-90% RH) while it was only nine days for the sulphite treated fruits.

Table:-3. Influence of pretreatments and packaging on organoleptic characteristics of litchi during cold storage

Treatments		Appearance		Taste		Odor		Texture		Overall acceptability	
		Packaging in polyethylene bags									
		Day 18	Day 27	Day 18	Day 27	Day 18	Day 27	Day 18	Day 27	Day 18	Day 27
T1	No treatment	-	-	-	-	-	-	-	-	-	-
T2	Suphitation	-	-	-	-	-	-	-	-	-	-
T3	HWT+1.5% HNO3 for 10 min+2% CaCl2 for 15 min	4.75	4.40	4.50	4.25	4.45	4.05	4.3	3.9	4.48	4.40
Mean		1.58	1.47	1.50	1.42	1.48	1.35	1.43	1.30	1.49	1.47
Treatments		Packaging in paper box									
T1	No treatment	-	-	-	-	-	-	-	-	-	-
T2	Suphitation	-	-	-	-	-	-	-	-	-	-
T3	HWT+1.5% HNO3 for 10 min+2% CaCl2 for 15 min	4.45	4.35	4.50	4.15	3.45	3.40	3.45	3.45	3.90	3.80
Mean		1.48	1.45	1.50	1.38	1.15	1.15	1.15	1.15	1.30	1.27

Table 3 showed that the organoleptic scores for all the sensory attributes namely appearance/colour, odour, taste, texture and overall acceptability exhibited declining trends with the progress of storage period due to all the treatments of corresponding maximum scores following 18 and 27 days of cold storage were eighteen day mean score 1.58, 1.50, 1.48, 1.43,1.49 and 1.47,1.42,1.35,1.30,1.47 for 27 days acceptability with packaging in 4% perforated polyethylene bags (165 gauze) whereas 18 days mean score 1.48,150,1.15,1.15,1.30 and twenty seven day mean score 1.45,1.38,1.13,1.15,1.27 after packaging in paper boxes (4% ventilation) were kept at cold conditions (4-5^0C, 85-90% RH) with the treatment T_3 (hot water dip at 55^0C for 12 min + 1.5%HNO_3 dip for 10 min +2%$CaCl_2$ for 15 min).

Discussion

Sensory profile is the ultimate criteria to adjudge the suitability of any pretreatment or method to be recommended for adoption by the concerned people. The findings of present investigation indicated that in the second set of experiment that was conducted at the ambient conditions neither the precooled treatment nor the hot water treatment alone or followed by HNO_3 dip treatment resulted into overall acceptable scores of stored litchi ≥3.0. This clearly shows that precooling, hot water, and hot water followed by HNO_3 dip treatment were not very effective treatments to extend the shelf-life of litchi fruits.

It seems that precooling, hot water and hot water-acid dip treatment which are employed for extracting the field heat from the produce, reducing surface microflora and disinfestations and for lowering the pH to retard browning are unable to minimize the changes in the sensory attributes of litchi during the ambient storage. Hence, $Ca(NO_3)_2$ that might be assumed to be produced due to the presence of HNO_3 and $CaCl_2$ was possibly responsible for retaining the most of the sensory properties of fruits during the four days storage of litchi at the ambient conditions. It might be due to decrease in the respiration rates and moisture losses from the fruits because of Ca $(NO_3)_2$. Several previous workers have reported **(Patra and Sadhu, 1992; Duvehage *et al.,* 1995; Ghosh *et al.,* 2003; Singh *et al.*, 2004)** various beneficial properties of Ca $(NO_3)_2$ treatment of fruits.

The results of this experiment revealed that the organoleptic characteristics of litchi fruits were affected least during the cold storage irrespective of types of packaging when subjected to hot water dip treatment

followed by dipping in 1.5%HNO_3 for 10 min and then in 2 % $CaCl_2$ solution for 15 min, prior to packaging and storage. The remarkable reductions in ratings for colour, odour and taste of sulfited litchi packed in either of the packaging type during the storage were due to bleaching of anthocyanins and unpleasant taste and odor caused by the SO_2 fumigation. The adverse effects of SO_2 on the sensory profile of sulfited litchi were observed earlier (**Markakis, 1982; Kremer and Lonsdale, 1990; Zauberman *et al.*, 1990; Underhill *et al.*, 1992b; Coates *et al.,* 1994; Ray *et al.*, 2004)**. Hence, hot water dip treatment (55^0C for 12min) followed by dipping in 1.5%HNO_3 for 10min and then in 2 % $CaCl_2$ solution for 15min may be considered to be an ideal alternative post-harvest treatment of litchi fruits in of place of sulphitation.

Conclusions

On the basis of above results, it is clear that this investigation indicates that treatment (T_5) HNO_3 (1.5% for 10 min and then $CaCl_2$ (2% for 15 min) dip treatment obtained the maximum sensory score by the sensory panelists and successfully to extend the shelf-life and retard browning of litchi (cv. Rose Scented). Litchi fruits dipped in chemical solution was the longest i.e. 4 days at ambient condition and also increase shelf life 27 days under the cold conditions (4-5^0C and 85-90% RH) after packaging in paper boxes and polyethylene bags.

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